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FILE

MEMO TO : All Portable Gauge Licensees

FROM : Jeffrey L. Burgess, P.E.
Director, Division of
Air Quality

RE : Operational Radiation Safety Journal Article: "Managing a Sound Portable Gauge Radiation Safety Program"

DATE : May 11, 2000

Enclosed is a copy of an article appearing in the May 2000 (Vol. 78, No. 5) edition of the Operational Radiation Safety Journal published by the Health Physics Society. The enclosed article entitled, "Managing a Sound Portable Gauge Radiation Safety Program" provides basic information needed to work safely around portable nuclear instruments and discusses licensing requirements and other information pertaining to the management of a portable gauge radiation safety program.

It is expected that you will review this information for applicability to your licensed activities and consider actions, as appropriate, to ensure the safe and legal use of radioactive materials in the State of North Dakota.

This notice is for your information only. No specific action nor written response is required. If you have any questions concerning this issue, please contact the Radiation Control Program at 701-328-5188.

JLB/JMG:csc
Enc:

The use of portable gauges requires adherence to a well-defined radiation safety program.

Managing a Sound Portable Gauge Radiation Safety Program

René Michel, T. L. Zimmerman,† and K. C. Kerns†*

Abstract: *At some construction engineering companies, individuals with no background in radiation safety sometimes are assigned the not always welcome title of Radiation Safety Officer (RSO). With this new title comes the responsibility of ensuring that portable gauges are used safely at their facilities and in the field. These newly appointed RSOs sometimes lack the knowledge and experience needed to manage a radiation safety program. This article was developed to provide the basic information needed to work confidently and safely around these instruments and to discuss licensing requirements and other information pertaining to the management of a portable gauge radiation safety program. Health Phys. 78(Supplement 2):S62–S66; 2000*

Key Words: *operational topic; radiation protection; occupational safety; monitors, radiation*

Portable gauges are instruments used in areas such as agriculture and construction engineering to obtain valuable information on the density or composition of a variety of surfaces (Fig. 1).

Even though these gauges contain relatively large amounts of radioactive material, they are safe to use when some simple precautions are followed. These precautions are not obvious, but are simple to follow. Radiation, unlike the heat from a flame or the sharpness of a blade, cannot be seen or felt, but the worker's safety is assured by following standard operating procedures.

Topics discussed in this article include the operation of portable gauges, basic radiation safety techniques, regulatory requirements, and key aspects in the management of a radiation safety program.

BASIC OPERATION

Portable gauges use one or two small radioactive sources about the size of a pencil eraser, most commonly ^{137}Cs, a gamma source, and ^{241}Am, a neutron source (Gardner and Ely 1967). These sources are small in size but can be highly radioactive. Typical activities for these sources are about 10 millicuries for ^{137}Cs and 50 millicuries for ^{241}Am. The source's housing (Fig. 2) shields the radiation emitted from these materials.

There are two basic methods of operation for portable gauges (U.S. NRC 1989):

1. Direct transmission: This method is considered the more precise of the two, as it offers less error in measuring composition and compensates for surface roughness. To measure soil density, for example, the source is placed in a tube and inserted through an access hole (Fig. 3). Radiation is then transmitted from the source to a detector on the base of the gauge. The radiation level at the detector determines the density of the soil.
2. Backscatter: This method eliminates the need for an access hole by allowing both the source and detector to remain on the surface. Radiation is directed beneath the surface, and some is reflected, or scattered, back to the gauge detector by the surface material (Fig. 4). This method can be less accurate than direct transmission due to the large scattering angle and shallow depth of measurement. It is also insensitive to density variations beyond a depth of two to three inches (5 to 8 cm). However, this method is quicker and easier than direct transmission and useful when measuring uniform materials such as asphalt paving.

REGULATORY ASPECTS

Since the radioactive material found in portable gauges can be

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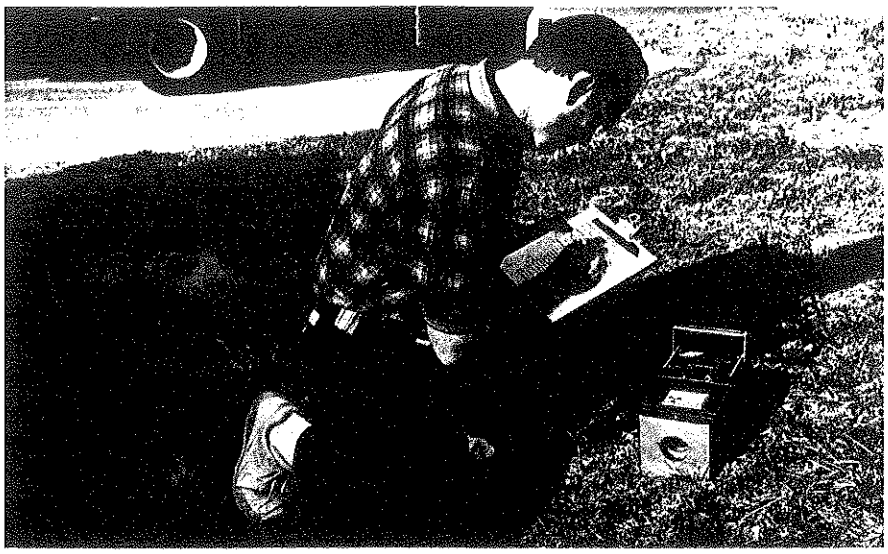

Figure 1. Portable gauges are used in agriculture and construction engineering to determine moisture content and levels of compaction of a variety of surfaces.

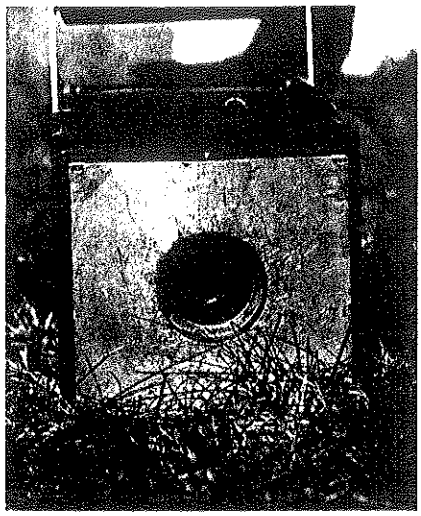

Figure 2. The source's housing shields the radiation emitted from the source rod. Only individuals specifically authorized by the regulatory agency must perform repair work that involves detaching the source rod from the instrument.

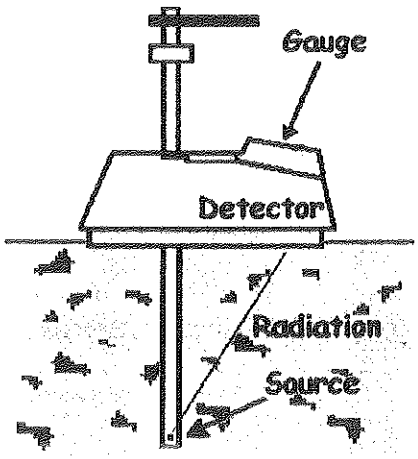

Figure 3. Direct transmission is the portable gauge method of operation used to determine levels of compaction of a variety of surfaces such as concrete and asphalt.

hazardous to the public if not used properly, its possession and use is regulated. In the United States, the federal agency in charge of controlling radioactive material is the Nuclear Regulatory Agency (NRC). Individual states are allowed to regulate themselves provided that they agree to follow the regulations set down by the NRC. These states are called Agreement States. Regulations enforced by the NRC are contained in Title 10 of the Code of Federal Regulations (U.S. NRC 1999). Each Agreement State writes its own set of regulations based on these regulations.

To possess and use portable gauges, organizations or individual users must obtain a radioactive material license. Typically both the NRC and Agreement States publish guides to help applicants in the licensing process. The NRC has published NUREG-1556, Vol. 1 (U.S. NRC 1997), an excellent report designed to assist potential licensees in preparing portable gauge applications.

Portable gauge regulations mandate compliance with some general requirements such as designating a person in the organization as the radiation safety officer who, besides being the contact person for the regulatory agency, also ensures that portable gauges are used only by authorized workers and in a safe manner. Other requirements include proper instruction to workers, the implementation of safe operating and emergency procedures, compliance with transportation regulations, leak testing, and radiation safety program audits.

Regulators perform periodical inspections to ensure compliance with these requirements. RSOs should prepare for unannounced inspections by reviewing available guidance on the subject (Michel and Lopez 1998). Inspectors may spend many hours reviewing procedures, observing users during the operation of gauges and interviewing personnel. The inspection length depends mainly on the size and condition of the radiation safety program.

BASIC RADIATION PROTECTION TECHNIQUES

The ALARA principle is the fundamental tenant of radiation safety. Federal regulations require the implementation of personal protective measures in order to maintain both occupational and non-occupational doses "As Low As Reasonably Achievable."

It is the responsibility of the radiation worker to keep his occupational dose ALARA. This can be achieved by reducing the amount of time spent working in the vicinity of these instruments, by increasing the distance from them and by using shielding when possible, especially during non-routine work such as gauge maintenance, leak testing, etc.

LICENSING REQUIREMENTS

As discussed above, regulatory agencies publish guidelines on the

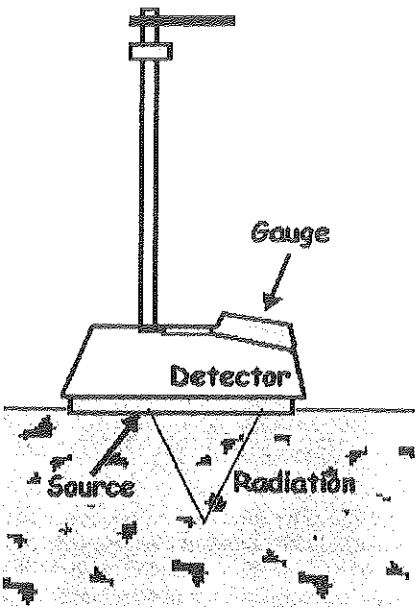

Figure 4. Backscatter is the portable gauge method of operation used to determine levels of moisture content in the soil.

licensing of portable gauges. These guidelines describe the type and extent of information needed by the regulatory agency to evaluate an application to use these instruments. Depending on the nature of the use, the regulatory agency may impose additional requirements. These requirements are called license conditions. A small description of the typical portable gauge regulatory requirements follows:

1. The implementation of an ALARA program: By law, licensees are required to implement reasonable measures to maintain occupational and non-occupational doses ALARA. Everybody in the organization including management, the RSO and portable gauge users is subject to this requirement. Regulations usually require a formal (i.e., written) policy commitment. This ALARA document should encourage the application of this concept within the organization. It should include areas such as formal annual reviews of the radiation safety program and quarterly reviews of occupational exposures.
2. Proper instruction to workers: Both the RSO and gauge users are required to successfully complete an approved training course. Some regulatory agencies also require gauge users to participate in an annual refresher training session. Traditionally, gauge vendors offer such courses. The RSO must keep these training records on file for regulators to review during their compliance inspections. RSOs may also consider providing proper hazard-awareness instruction to non-gauge users whose duties may require them to work in the vicinity of these instruments (Michel and Kerns 1998).
3. Source security: Licensees are required to prevent access to portable gauges by unauthorized individuals. Gauges are considered secure if they are physically attended while in use or are kept locked when not in use. While in storage, portable gauges must be locked in such a way that unauthorized personnel cannot gain access to them. The storage area must be posted with a radioactive material sign, and radiation levels outside this area must not exceed any regulatory limits. At field locations gauges can be locked in the trunk of a vehicle, hidden from view while in a locked van, or secured by lock and chain while in an open bed truck. It is not acceptable for a portable gauge to be chained to a post or left unattended at the place of use while taking a break since the instrument would be accessible to unauthorized individuals. It is the responsibility of the RSO to implement measures to assure that gauges are secure at all times and the responsibility of the users to observe them. Lack of source security is one of the most serious violations identified during compliance inspections.
4. Personnel monitoring: Regulations require workers who could exceed 10% of the annual dose limits to wear either a film badge or a TLD while working with portable gauges. Proper use of portable gauges will result in minimal radiation exposure to workers; nevertheless, some regulators argue that significant radiation exposure can occur if portable gauges are improperly used, thus requiring dosimetry. Even though most workers may not be required to be monitored, some licensees still issue dosimetry to portable gauge users as a long-term legal protection. Workers found not wearing their assigned dosimeters while working with gauges is one of the most common violations identified during compliance inspections.
5. Appropriate radiation detection instruments: Each year there are many incidents involving portable gauges at construction sites, most commonly heavy machinery running over them. It is important to determine as soon as possible after an incident, by the use of a radiation survey meter (Fig. 5), whether the shielding and source are intact. If radiation survey meters are required during emergency or routine use, they are to be calibrated annually and after

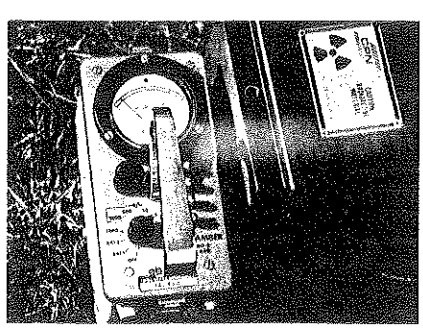

Figure 5. Radiation survey meters are used mainly to verify that the source rod is in the safe position and after emergencies to determine whether the source and shielding are intact.

repairs. Before using a survey meter, workers should check the instrument's calibration date, perform a battery test, and check the response of the instrument with a known source of radiation (i.e., portable gauge). If any of these tests fail, the RSO should be contacted immediately. Licensees occasionally receive notices of violation for not using these instruments properly.

6. Leak testing: Even though the radioactive material in portable gauges is doubly encapsulated in stainless steel, licensees are still required to verify that radioactive sources are not leaking. Approved leak tests are to be performed in 6-mo intervals by the RSO or another qualified individual. Leak test kits (i.e., cotton swabs or filter paper) are commercially available. Wipes should be kept separate to avoid cross contamination. While performing leak tests, it is important to identify each gauge tested by recording serial numbers, nuclide, and activity. Improper wipe testing documentation is a common problem found during compliance inspections. Wipes should be taken from the most accessible area where contamination would accumulate if the sealed source were leaking (Fig. 6). Leak test wipes should be analyzed using appropriate and calibrated counting equipment and by a knowledgeable or licensed individual.
7. Proper maintenance: All routine maintenance work such as cleaning and lubrication of the source rod and shutter mechanism should be performed with the radioactive source in the safe position (i.e., shielded). Routine gauge maintenance work is typically performed by the RSO or by another qualified individual. Only the manufacturers or other approved procedures should be followed. The ALARA techniques (time, distance, and shielding) along with common sense should be applied while performing this type of work. The source rod should never be touched. The gauge manufacturer or an individual specifically authorized by the regulatory agency must perform non-routine maintenance or repair work that involves detaching the source or source rod from the instrument.
8. Compliance with transportation requirements: Packing and transportation of portable gauges must comply with the Department of Transportation (DOT) Regulations. These requirements include a special form certificate, package testing results, marking, and labeling (the package must be marked with the proper shipping name and labeled on opposite sides). Most portable gauge cases are type A packages and require the Yellow II label. Also required are emergency response information, locking or sealing of package, inspection prior to shipment, and a properly completed Bill of Lading. This document must be in the transport vehicle and immediately accessible to the driver. A typical bill of lading includes the following information: the name of the shipper, a description of the shipment, an emergency response phone number, the shipper's certification, and the shipper's signature. The description of the shipment includes information such as the proper shipping name (the words reportable quantity, "RQ," must be added to this name), hazard class, identification number, type of package, name and activity of each nuclide, category of labeling, and transportation index (TI).
9. Operating and emergency procedures: A copy of approved operating and emergency procedures should be always readily available for portable gauge operators to use. Operating procedures should address the following areas: The proper use of personal monitors and step-by-step information on how to operate, store and transport portable gauges. Emergency procedures should address information on how to properly respond to emergencies,

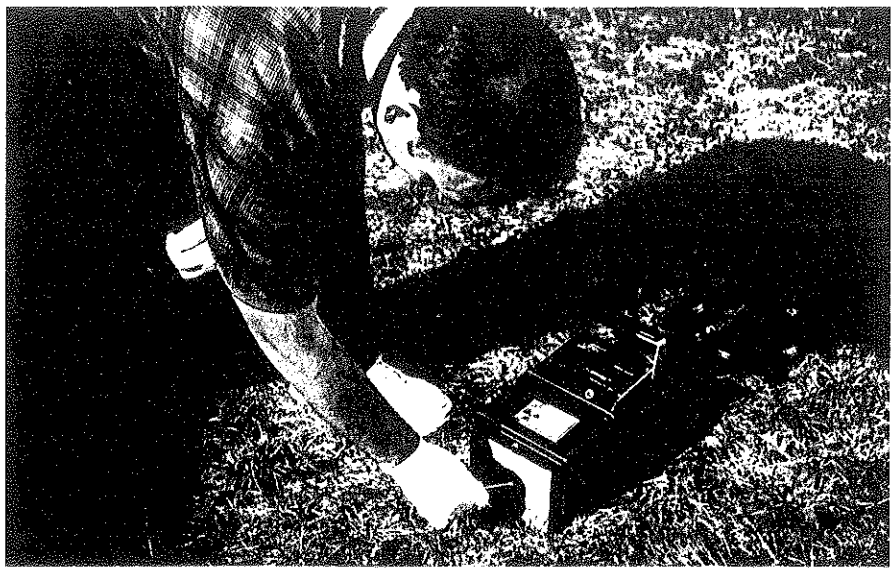

Figure 6. To verify that sources are not leaking, portable gauge licensees are required to perform periodical leak tests.

such as when the source fails to return to the shielded position, the gauge gets struck by a vehicle, is dropped or is involved in an accident. The RSO with the help of portable gauge users should periodically review and improve emergency procedures.

10. Inventory: Regulatory agencies typically require portable gauge licensees to conduct an inventory of all gauges possessed at least once every six months. Inventory records should include the nuclide and amount of material in each source, the manufacturer's name, model number and serial number of each gauge and their storage location.
11. Disposal: Because of the nature of the radioactive material contained in these gauges, the only methods of disposal are by transfer to an authorized recipient, such as a commercial firm authorized to receive radioactive waste or another licensee authorized to posses such material.
12. Annual audit: Most regulatory agencies require an annual audit of the radiation safety program to ensure that proper safety and operating procedures are being followed. These audits are more effective when they are performed unannounced in the field where gauges are normally used. Inspectors review records of these audits during their periodical visits. RSOs may perform these audits themselves or consider hiring a consultant. This option may be costly. A good alternative is to participate in a reciprocity program with another portable gauge licensee (Michel and Eichner 1999).

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